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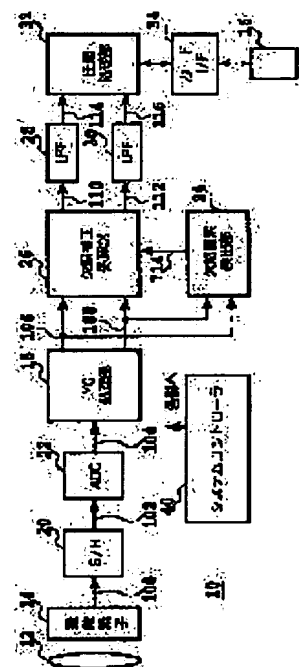
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## (54) PIXEL DEFECT CORRECTION DEVICE, PIXEL DEFECT DETECTOR AND PIXEL DEFECT DETECTING METHOD

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a pixel defect correction device, a pixel defect detector and a pixel defect detecting method that can correct a defective pixel and stably detect the defective pixel without increasing the circuit scale in response to a color filter of an image pickup element.

**SOLUTION:** A defect pixel detection section 24 and a defect correction processing section 26 receive YC image signals that are processed by a YC conversion processing section respectively, the defect pixel detection section 24 detects a defective pixel in a picked-up image by an image pickup element 14 on the basis of a pixel value of its surrounding pixels and the defect correction processing section 26 corrects the pixel value of the defective pixel on the basis of the defect information depending on the detection.



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**CLAIMS**

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[Claim(s)]

[Claim 1] In the pixel defective compensator which inputs the pixel signal outputted from the image sensor on which the color filter was put, and amends the pixel signal by the defective pixel in this image sensor this equipment An input means by which said pixel signal inputs the picture signal changed into the brightness component and the color difference component, A defective information output means to output the defective information according to the location of said defective pixel, Said defective amendment means is a pixel defective compensator characterized by amending and outputting the pixel value of the pixel according to said defective information with the pixel value of the contiguity pixel of this pixel including a defective amendment means to amend the defective pixel in the picture signal inputted into said input means.

[Claim 2] It is the pixel defective compensator characterized by said defective amendment means amending the pixel value of the pixel according to said defective information in a compensator according to claim 1 with the pixel value of the picture signal of said brightness component and said color difference component.

[Claim 3] Said input means is a pixel defective compensator characterized by inputting the picture signal changed with this conversion means including a conversion means for this equipment to change said pixel signal into a brightness component and a color difference component, and to output said picture signal in a compensator according to claim 1.

[Claim 4] In a compensator according to claim 3 said conversion means The high-frequency component and low-pass component of this picture signal are generated using the pixel which adjoins perpendicularly to the pixel in said picture signal. Generate the luminance signal of these quantities region and a low-pass component to said brightness component, and the color-difference signal of the color difference component of this picture signal is generated using the pixel which adjoins said processing-object pixel perpendicularly further. Said defective amendment means is a pixel defective compensator characterized by amending said luminance signal and color-difference signal.

[Claim 5] It is the pixel defective compensator characterized by supplying the defective information according to the detection result of this detection means to said defective amendment means including a detection means by which said defective information output means detects the variation of said picture signal in a compensator according to claim 1.

[Claim 6] In a compensator according to claim 5 said detection means The 1st acquisition means which acquires the pixel value of the object pixel circumference, and the 2nd acquisition means which acquires the pixel value of said object pixel, Based on each pixel value acquired with the 1st and 2nd acquisition means, this judgment means is a pixel defective compensator characterized by outputting the defective information according to this judgment result to said defective amendment means including a judgment means to judge whether said object pixel is determined as a defective pixel.

[Claim 7] It is the pixel defective compensator characterized by to output the defective information according to this comparison result to said defective amendment means including a comparison means compare with said pixel value average an equalization means compute a pixel value average by equalizing the pixel value from which said judgment means was acquired with said 1st acquisition means in the compensator according to claim 6, and the pixel value of said object pixel.

[Claim 8] It is the pixel defective compensator characterized by carrying out the comparison test of whether said comparison means has the pixel value of said object pixel within the limits of predetermined [ of said pixel value average ] in a compensator according to claim 7.

[Claim 9] a compensator according to claim 8 -- setting -- said comparison means -- the difference of said pixel value average and pixel value of said object pixel -- an operation means to compute an absolute value -- containing -- this -- difference -- the pixel defective compensator characterized by carrying out the comparison test of whether an absolute value is within the limits of predetermined [ said ].

[Claim 10] It is the pixel defective compensator characterized by including a setting means by which this equipment sets said predetermined range as adjustable in a compensator according to claim 8 or 9.

[Claim 11] It is the pixel defective compensator characterized by said equalization means computing the pixel value average of the field except this object pixel in a compensator according to claim 7 among the pixels of the in-every-direction  $m \times n$  pixel ( $m$  and  $n$  are three or more odd number) of the circumference centering on said object pixel.

[Claim 12] It is the pixel defective compensator characterized by said equalization means computing the pixel value average of  $5 \times 5$  pixels of every direction of the field except said object pixel in a compensator according to claim 11.

[Claim 13] It is the pixel defective compensator characterized by connecting a low pass mold filter means to the output of said defective amendment means in a compensator according to claim 5, as for this equipment.

[Claim 14] As a result of said positional information output means' inspecting the defective pixel of said image sensor in a compensator according to claim 1, said defective amendment means is a pixel defective compensator characterized by amending the pixel value of the pixel according to said positional information as defective information judged to be a defective pixel including a storage means to memorize beforehand the positional information showing the location of this defective pixel.

[Claim 15] It is the pixel defective compensator which, as for this equipment, a low pass mold filter means is connected to the output of said conversion means in a compensator according to claim 14, and is characterized by said defective amendment means performing amendment processing of said defective pixel about the picture signal outputted from this low pass mold filter means.

[Claim 16] It is the pixel defective compensator which said defective amendment means is the contiguity pixel value of in front of the pixel for defective amendment, and/or the back in a compensator according to claim 1, and is characterized by interpolating the pixel value of said object pixel.

[Claim 17] It is the pixel defective compensator which said defective amendment means is the pixel value of front Rhine of the pixel for defective amendment, and/or back Rhine in a compensator according to claim 1, and is characterized by interpolating the pixel value of said object pixel.

[Claim 18] According to the color component of the color filter with which the image pick-up cel [ in / means / said / defective amendment / on a compensator according to claim 1 and / in the pixel location of the pixel for amendment / said image sensor ] was covered, it is the pixel defective compensator characterized by choosing the amendment approach.

[Claim 19] It is the pixel defective compensator characterized by for said color filter being a RGB primary color color filter, and said conversion means generating said picture signal from the RGB pixel signal outputted from said image sensor in a compensator according to claim 3.

[Claim 20] It is the pixel defective compensator characterized by being the color filter with which said RGB primary color color filter arranged RB in checkers in G stripe array in the compensator according to claim 19.

[Claim 21] It is the pixel defective compensator characterized by for said color filter being a complementary color color filter, and said conversion means generating said picture signal from the complementary color signal outputted from said image sensor in a compensator according to claim 3.

[Claim 22] It is the defective pixel compensator characterized by this equipment containing said image sensor in a compensator according to claim 1.

[Claim 23] It is the defective pixel compensator characterized by including a record means to process the picture signal with which this equipment is outputted from said defective amendment means in a compensator according to claim 1, and to record on an information storage.

[Claim 24] In the pixel defective detection equipment which inputs the pixel signal outputted from the image sensor on which the color filter was put, and detects the pixel signal by the defective pixel in this image sensor this equipment An input means by which said pixel signal inputs the picture signal changed into the brightness component and the color difference component, and a detection means to detect the variation of said picture signal are included. This detection means The 1st acquisition means which acquires the pixel value of said object pixel circumference, and the 2nd acquisition means which acquires the pixel value of said object pixel,

Based on each pixel value acquired with the 1st and 2nd acquisition means, this judgment means is pixel defective detection equipment characterized by outputting this judgment result including a judgment means to judge whether said object pixel is determined as a defective pixel.

[Claim 25] It is pixel defective detection equipment characterized by to output said judgment result according to this comparison result including a comparison means compare with said pixel value average an equalization means compute a pixel value average by equalizing the pixel value from which said judgment means was acquired with said 1st acquisition means in detection equipment according to claim 24, and the pixel value of said object pixel.

[Claim 26] It is pixel defective detection equipment characterized by carrying out the comparison test of whether said comparison means has the pixel value of said object pixel within the limits of predetermined [ of said pixel value average ] in detection equipment according to claim 25.

[Claim 27] detection equipment according to claim 26 -- setting -- said comparison means -- the difference of said pixel value average and pixel value of said object pixel -- an operation means to compute an absolute value -- containing -- this -- difference -- the pixel defective detection equipment characterized by carrying out the comparison test of whether an absolute value is within the limits of predetermined [ said ].

[Claim 28] It is pixel defective detection equipment characterized by including a setting means by which this equipment sets said predetermined range as adjustable in detection equipment according to claim 26 or 27.

[Claim 29] It is pixel defective detection equipment characterized by said equalization means computing the pixel value average of the field except this object pixel in detection equipment according to claim 25 among the pixels of the in-every-direction  $m \times n$  pixel ( $m$  and  $n$  are three or more odd number) of the circumference centering on said object pixel.

[Claim 30] It is pixel defective detection equipment characterized by said equalization means computing the pixel value average of  $5 \times 5$  pixels of every direction of the field except said object pixel in detection equipment according to claim 29.

[Claim 31] Said input means is pixel defective detection equipment characterized by inputting the picture signal changed with this conversion means including a conversion means for this equipment to change said pixel signal into a brightness component and a color difference component, and to output said picture signal in detection equipment according to claim 24.

[Claim 32] It is pixel defective detection equipment characterized by to generate the high-frequency component and the low-pass component of this pixel signal using the pixel which adjoins a pixel [ in / on detection equipment according to claim 31 and / in said conversion means / said pixel signal ] perpendicularly, to generate the luminance signal of these quantities region and a low-pass component to said brightness component, and to generate the color-difference signal of the color-difference component of this pixel signal using the pixel which adjoins said processing-object pixel perpendicularly further.

[Claim 33] In the pixel defective amendment approach which inputs the pixel signal outputted from the image sensor on which the color filter was put, and amends the pixel signal by the defective pixel in this image sensor this approach The input process as which said pixel signal inputs the picture signal changed into the brightness component and the color difference component, The defective information output process which outputs the defective information according to the location of said defective pixel, Said defective amendment process is the pixel defective amendment approach characterized by amending the pixel value of the pixel according to said defective information with the pixel value of the contiguity pixel of this pixel including the defective amendment process which amends the defective pixel in the picture signal inputted at said input process.

[Claim 34] It is the pixel defective amendment approach characterized by said defective amendment process amending the pixel value of the pixel according to said defective information in the amendment approach according to claim 33 with the pixel value of the picture signal of said brightness component and said color difference component.

[Claim 35] Said input process is the pixel defective amendment approach characterized by inputting the picture signal changed at this conversion process including the conversion process which this approach changes said pixel signal into a brightness component and a color difference component, and outputs said picture signal in the amendment approach according to claim 33.

[Claim 36] In the amendment approach according to claim 35 said conversion process The high-frequency component and low-pass component of this picture signal are generated using the pixel which adjoins perpendicularly to the pixel in said picture signal. Generate the luminance signal of these quantities region and a

low-pass component to said brightness component, and the color-difference signal of the color difference component of this picture signal is generated using the pixel which adjoins said processing-object pixel perpendicularly further. Said defective amendment process is the pixel defective amendment approach characterized by amending said luminance signal and color-difference signal.

[Claim 37] It is the pixel defective amendment approach characterized by generating the defective information according to the detection result in this detection process including the detection process at which said defective information output process detects the variation of said picture signal in the amendment approach according to claim 33.

[Claim 38] In the amendment approach according to claim 37 said detection process The 1st acquisition process which acquires the pixel value of said object pixel circumference, and the 2nd acquisition process which acquires the pixel value of said object pixel, Based on each pixel value acquired at the 1st and 2nd acquisition processes, this judgment process is the pixel defective amendment approach characterized by generating the defective information according to this judgment result including the judgment process which judges whether said object pixel is determined as a defective pixel.

[Claim 39] It is the pixel defective amendment approach characterized by generating the defective information according to this comparison result including the comparison process which compares the pixel value of said object pixel with said pixel value average an average chemically-modified [ which computes a pixel value average by equalizing the pixel value from which said judgment process was acquired with said 1st acquisition means in the amendment approach according to claim 38 ] degree.

[Claim 40] It is the pixel defective amendment approach characterized by carrying out the comparison test of whether said comparison process has the pixel value of said object pixel within the limits of predetermined [ of said pixel value average ] in the amendment approach according to claim 39.

[Claim 41] the amendment approach according to claim 40 -- setting -- said comparison process -- the difference of said pixel value average and pixel value of said object pixel -- the operation process which computes an absolute value -- containing -- this -- difference -- the pixel defective compensator characterized by carrying out the comparison test of whether an absolute value is within the limits of predetermined [ said ].

[Claim 42] It is the pixel defective amendment approach characterized by including the setting process at which this approach sets said predetermined range as adjustable in the amendment approach according to claim 40 or 41.

[Claim 43] It is the pixel defective amendment approach characterized by an average chemically-modified [ said ] degree computing the pixel value average of the field except this object pixel in the amendment approach according to claim 39 among the pixels of the in-every-direction mxn pixel (m and n are three or more odd number) of the circumference centering on said object pixel.

[Claim 44] It is the pixel defective compensator characterized by an average chemically-modified [ said ] degree computing the pixel value average of 5x5 pixels of every direction of the field except said object pixel in the amendment approach according to claim 43.

[Claim 45] It is the pixel defective amendment approach characterized by performing low pass mold filtering to the picture signal with which this approach was amended at said defective amendment process in the amendment approach according to claim 37.

[Claim 46] As a result of said positional-information output process's inspecting the defective pixel of said image sensor in the amendment approach according to claim 33, said defective amendment process is the pixel defective amendment approach characterized by to amend the pixel value of the pixel according to said positional information as defective information judged to be a defective pixel including the storage process which memorizes beforehand the positional information showing the location of this defective pixel.

[Claim 47] It is the pixel defective amendment approach which this approach performs low pass mold filtering in the amendment approach according to claim 46 to the picture signal amended at said conversion process, and is characterized by said defective amendment process performing amendment processing of said defective pixel about this picture signal by which low pass mold filtering was carried out.

[Claim 48] It is the pixel defective amendment approach which said defective amendment process is the contiguity pixel value of in front of the pixel for defective amendment, and/or the back in the amendment approach according to claim 33, and is characterized by interpolating the pixel value of said object pixel.

[Claim 49] It is the pixel defective amendment approach which said defective amendment process is the pixel value of front Rhine of the pixel for defective amendment, and/or back Rhine in the amendment approach

according to claim 33, and is characterized by interpolating the pixel value of said object pixel.

[Claim 50] According to the color component of the color filter with which the image pick-up cel [ in / process / said / defective amendment / on the amendment approach according to claim 33 and / in the pixel location of the pixel for amendment / said image sensor ] was covered, it is the pixel defective amendment approach characterized by choosing the amendment approach.

[Claim 51] It is the pixel defective amendment approach characterized by said conversion process generating said picture signal from the RGB pixel signal outputted from said image sensor when said color filter is a RGB primary color color filter in the amendment approach according to claim 35.

[Claim 52] It is the pixel defective amendment approach characterized by being the color filter with which said RGB primary color color filter arranged RB in checkers in G stripe array in the amendment approach according to claim 51.

[Claim 53] It is the pixel defective amendment approach characterized by said conversion process generating said picture signal from the complementary color signal outputted from said image sensor when said color filter is a complementary color color filter in the amendment approach according to claim 35.

[Claim 54] It is the defective pixel amendment approach characterized by including the record process which processes the picture signal with which this approach was amended at said defective amendment process in the amendment approach according to claim 33, and is recorded on an information storage.

[Claim 55] In the pixel defective detection approach of inputting the pixel signal outputted from the image sensor on which the color filter was put, and detecting the pixel signal by the defective pixel in this image sensor this approach The input process as which said pixel signal inputs the picture signal changed into the brightness component and the color difference component, and the detection process which detects the variation of said picture signal are included. This detection process The 1st acquisition process which acquires the pixel value of said object pixel circumference, and the 2nd acquisition process which acquires the pixel value of said object pixel, Based on each pixel value acquired at the 1st and 2nd acquisition processes, this judgment process is the pixel defective detection approach characterized by outputting this judgment result including the judgment process which judges whether said object pixel is determined as a defective pixel.

[Claim 56] It is the pixel defective detection approach characterized by to output said judgment result according to this comparison result including the comparison process which compares the pixel value of said object pixel with said pixel value average an average chemically-modified [ which computes a pixel value average by equalizing the pixel value from which said judgment process was acquired with said 1st acquisition means in the detection approach according to claim 55 ] degree.

[Claim 57] It is the pixel defective detection approach characterized by carrying out the comparison test of whether said comparison process has the pixel value of said object pixel within the limits of predetermined [ of said pixel value average ] in the detection approach according to claim 56.

[Claim 58] the detection approach according to claim 57 -- setting -- said comparison process -- the difference of said pixel value average and pixel value of said object pixel -- the operation process which computes an absolute value -- containing -- this -- difference -- the pixel defective detection approach characterized by carrying out the comparison test of whether an absolute value is within the limits of predetermined [ said ].

[Claim 59] It is the pixel defective detection approach characterized by including the setting process at which this approach sets said predetermined range as adjustable in the detection approach according to claim 57 or 58.

[Claim 60] It is the pixel defective detection approach characterized by an average chemically-modified [ said ] degree computing the pixel value average of the field except this object pixel in the detection approach according to claim 56 among the pixels of the in-every-direction mxn pixel (m and n are three or more odd number) of the circumference centering on said object pixel.

[Claim 61] It is the pixel defective detection approach characterized by an average chemically-modified [ said ] degree computing the pixel value average of 5x5 pixels of every direction of the field except said object pixel in the detection approach according to claim 60.

[Claim 62] Said input process is the pixel defective detection approach characterized by inputting the picture signal changed at this conversion process including the conversion process which this approach changes said pixel signal into a brightness component and a color difference component, and outputs said picture signal in the detection approach according to claim 55.

[Claim 63] It is the pixel defective detection approach characterized by to generate the high-frequency component and the low-pass component of this pixel signal using the pixel which adjoins a pixel [ in / on the

detection approach according to claim 62 and / in said conversion process / said pixel signal ] perpendicularly, to generate the luminance signal of these quantities region and a low-pass component to said brightness component, and to generate the color-difference signal of the color-difference component of this pixel signal using the pixel which adjoins said processing-object pixel perpendicularly further.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention inputs the pixel signal outputted from the image sensor on which the color filter was put, detects the pixel signal by the defective pixel in an image sensor, and relates to the pixel defective compensator, the pixel defective detection equipment, and the approach of amending the pixel defect in the solid state image sensor with which the pixel defective compensator, the pixel defective detection equipment, and the approach of amending were started, for example, the primary color filter was put on the image pick-up side.

[0002]

[Description of the Prior Art] In recent years, a field is picturized, the field image and image are digitized, and a magnetic tape, a rotation record medium, and the digital camera further recorded on semiconductor memory are spreading. A CCD solid state image sensor and an MOS type pickup device are carried in such a camera, and the demand to the formation of a high pixel consistency has been increasing to it.

[0003] For example, with a digital still camera, the solid state image sensor which has an image pick-up cel 1 million pixels or more has come to be used. The various color filters for forming a color picture are carried in such each image pick-up cel of the image sensor of the veneer.

[0004] However, in each image pick-up cel, the so-called crack by which the charge according to light income is not generated from various reasons occurs. When that image was displayed, the pixel signal corresponding to the cel, i.e., the defective pixel, of this crack condition was conspicuous according to the situation, and had become the cause of lowering the quality of a special photography image.

[0005] Then, when using such a color image sensor, the amendment method of various kinds of defective pixels is developed and put in practical use.

[0006] For example, the solid state camera which carries out defective amendment after carrying out sample hold of the output of the color CCD image sensor of color coating of a complementary color check method and digitizing it, performs various kinds of signal processing to the CCD output by which defective amendment was carried out, and obtains a video outlet was indicated by JP,6-30425,A.

[0007] Moreover, the information about a defective pixel is memorized to nonvolatile memory, and the defective pixel detection system of a CCD solid state image sensor was indicated by JP,9-205586,A. It was that by which the defective pixel detection amendment circuit for performing detection and its amendment of a defective pixel is prepared between the solid state image sensor and the digital disposal circuit in this official report.

[0008]

[Problem(s) to be Solved by the Invention] However, at the former, since defective pixel amendment was performed before signal processing, by the case where software performs amendment processing, there was a problem that it was restricted to the number of pixels which can be amended in the time limit according to signal processing.

[0009] Moreover, especially in the color image sensor of the veneer, interpolation processing needed to be carried out by few RGB pixels of a pixel according to a color filter array, i.e., the pixel which adjoins between same color color filters, for this reason, many the Rhine memory, registers, etc. holding a surrounding pixel in an amendment circuit were needed, and there was a problem that an amendment circuit was complicated. That is, when amending a defective pixel, if the pixel of in front of the pixel for amendment and the back and the

pixel of the color filter of the same color contiguity pixel of vertical Rhine are used, in order for the distance between pixels to become large and to carry out storage maintenance of such a pixel, many store circuits, such as the Rhine memory and a register, needed to be prepared in the amendment circuit.

[0010] This invention cancels the fault of such a conventional technique, a defective pixel can be amended, without a circuit scale increasing according to the color filter which an image sensor has, and it aims at offering the pixel defective compensator, the pixel defective detection equipment, and the approach of being stabilized and detecting a defective pixel.

[0011]

[Means for Solving the Problem] In the pixel defective compensator which this invention inputs the pixel signal outputted from the image sensor on which the color filter was put in order to solve an above-mentioned technical problem, and amends the pixel signal by the defective pixel in an image sensor. An input means by which this equipment inputs the picture signal from which the pixel signal was changed into the brightness component and the color difference component, A defective information output means to output the defective information according to the location of a defective pixel, and a defective amendment means to amend the defective pixel in the picture signal inputted into an input means are included. A defective amendment means It is characterized by amending and outputting the pixel value of the pixel according to defective information with the pixel value of the contiguity pixel of this pixel.

[0012] Moreover, in order to solve an above-mentioned technical problem, this invention inputs the pixel signal outputted from the image sensor on which the color filter was put, and sets it to the pixel defective detection equipment which detects the pixel signal by the defective pixel in an image sensor. This equipment includes an input means by which a pixel signal inputs the picture signal changed into the brightness component and the color difference component, and a detection means to detect the variation of a picture signal. A detection means The 1st acquisition means which acquires the pixel value of the object pixel circumference, and the 2nd acquisition means which acquires the pixel value of an object pixel, Based on each pixel value acquired with the 1st and 2nd acquisition means, a judgment means is characterized by outputting a judgment result including a judgment means to judge whether an object pixel is determined as a defective pixel.

[0013] Furthermore, in order to solve an above-mentioned technical problem, this invention inputs the pixel signal outputted from the image sensor on which the color filter was put, and sets it to the pixel defective amendment approach which amends the pixel signal by the defective pixel in an image sensor. The input process as which, as for this approach, a pixel signal inputs the picture signal changed into the brightness component and the color difference component, A defective amendment process is characterized by amending the pixel value of the pixel according to defective information with the pixel value of the contiguity pixel of this pixel including the defective information output process which outputs the defective information according to the location of a defective pixel, and the defective amendment process which amends the defective pixel in the picture signal inputted at an input process.

[0014] Moreover, in order to solve an above-mentioned technical problem, this invention inputs the pixel signal outputted from the image sensor on which the color filter was put, and sets it to the pixel defective detection approach of detecting the pixel signal by the defective pixel in an image sensor. This approach includes the input process as which a pixel signal inputs the picture signal changed into the brightness component and the color difference component, and the detection process which detects the variation of a picture signal. A detection process The 1st acquisition process which acquires the pixel value of the object pixel circumference, and the 2nd acquisition process which acquires the pixel value of an object pixel, Based on each pixel value acquired at the 1st and 2nd acquisition processes, a judgment process is characterized by outputting a judgment result including the judgment process which judges whether an object pixel is determined as a defective pixel.

[0015]

[Embodiment of the Invention] Next, the example which applied the pixel defective compensator by this invention to the digital camera with reference to the accompanying drawing is explained to a detail. If drawing 1 is referred to, photo electric conversion of the optical image by which image formation is carried out through the image pick-up lens 12 is carried out with an image sensor 14, and the digital camera 10 which generates the color picture signal according to a field image, and is stored in the information storage of memory card 16 grade is shown. This digital camera 10 has the function to correct the defective pixel generated with an image sensor 14, by performing detection processing and amendment processing of a defective pixel to the output signal of

YC processing section 18. In addition, the part which does not have the direct relation to this invention in the following explanation omits illustration and its explanation, and the reference mark of a signal is expressed with the reference number of the appearing path cord.

[0016] An image sensor 14 is an output 100 as a pixel signal with which a perpendicular and multiple image pick-up cel is formed horizontally, the charge according to the amount of the light which reaches the photodiode of each cel is generated, this is read through two or more perpendicular charge transfer ways and level charge transfer ways corresponding to each cel, and the pixel value according to the light income of each cel is expressed. It is the solid state image sensor to output. The color filter with which the spectral characteristics for generating the micro lens and color picture which condense the flux of light from the image pick-up lens 12 differ is formed in the light-receiving side of each cel, in this example, the primary color color filter of the filter array shown in drawing 2 is put, and the image pick-up cel from which the spectral sensitivity characteristic differs in every R-G-B (red, green, and blue), respectively is formed. This color filter is a color filter of a G stripe RB perfect check array with which G filter is perpendicularly arranged in the shape of a stripe, and the color filter train of RB and BR is arranged by turns for between [ every ] G filter trains.

[0017] The black crack which shows the white crack which the image pick-up cel which does not generate the electrical signal according to light income occurs in a solid state image sensor, for example, generally indicates the pixel of a bright condition to be light income to it independently from the problem on the manufacture, and a dark condition is included in the output signal. If it sorts out so that these may be lost completely, it will lead to the fall of the yield. Then, according to extent of the crack generating, amending the pixel value from the image pick-up cel of the crack condition is performed to the output signal of an image sensor. For example, supposing specific R pixels were a defective pixel, amending the pixel value of a defective pixel was performed to the defective pixel using other values of R pixels which adjoin paying attention to the same color component. However, it is the pixel signal 100, without being based on such an approach in this example. It is constituted so that defective amendment may be performed to the luminance signal Y changed and generated and YC picture signal of a color-difference signal C and such a YC picture signal may detect a defective pixel.

[0018] output 100 of an image sensor 14 \*\*\*\* -- the dot order according to a filter array -- the following RGB a pixel signal should be outputted and pass a non-illustrated correlation duplex sampling circuit -- it is inputted into the sample hold circuit 20. RGB held here Point sequential pixel signal 102 Analog-to-digital conversion (ADC) It is changed into a digital image signal discrete in a circuit 22.

[0019] Analog-to-digital conversion (ADC) Output 104 of a circuit Connecting with YC processing section 18, YC processing section 18 is ADC. RGB outputted from a circuit 22 Pixel signal 104 It is the processing circuit changed into a luminance signal Y and YC picture signal of a color-difference signal C.

[0020] A front Rhine pixel [ in / to the pixel of a processing object / in YC processing section 18 in this example / Rhine in front of one ], 3 pixels by which the direction of a perpendicular (length) with the back Rhine pixel in Rhine after one has been arranged up and down, Or a luminance signal Y and color-difference signals Cr and Cb as generated the high-frequency component YH and the low-pass component YL of a picture signal and shown in drawing 3 thru/or drawing 5 using 6 pixels which added 3 pixels which adjoins in it horizontally It generates.

[0021] RGB digitized in detail as YC processing section 18 was shown in drawing 6 Pixel signal 104 Buffer memory 600 stored temporarily Buffer memory 600 from -- RGB read Pixel signal 602 choosing -- desired outputs 604a, 604b, 604c, and 604d the selection circuitry (SEL) to output -- 606 It has. YH generation processing section 608 connected to the output 604a, and YL generation processing section 610 connected to output 604b The high-frequency component YH and the low-pass component YL of a luminance signal are computed by the predetermined operation approach using the 3-pixel value distributed over the lengthwise direction inputted. YH generation processing section 608 a high-frequency component YH output -- adder 612 one input and low pass filter (LPF) -- 614 it connects -- having -- YL generation processing section 610 a low-pass component output -- adder 612 It connects with the input of another side. adder 612 a high-frequency component YH and the low-pass component YL -- compounding -- signal (YL-YH) generating -- a low pass filter (LPF) -- 616 It supplies. Adder 618 Each LPF 614,616 The luminance signal of (YL-YH)+YH for the processed component signal is compounded, and it is an output 106 about a luminance signal Y. It outputs.

[0022] selection circuitry 606 Outputs 604c and 604d Cr generation processing section 620 connected, respectively And Cb generation processing section 622 the 3-pixel value or a 6-pixel value which was

mentioned above distributed perpendicularly similarly -- using -- color difference components Cr and Cb generating -- a low pass filter (LPF) -- 624,626 respectively -- these color difference component -- filtering -- carrying out -- color-difference signal C (Cr, Cb) It outputs to an output 108.

[0023] thus, YC processing circuit 18 -- RGB RGB [ in / interpolation processing is carried out from pixel data, and / each pixel location ] after computing each pixel value, YC processing is not performed but it adjoins -- each signal of brightness and a color difference component is generated from 3 pixels long at least. Output 106 of YC processing circuit 18 And 108 It connects with the defective pixel detecting element 24 and the defective amendment processing section 26, respectively.

[0024] The defective pixel detecting element 24 is an input 106,108. It is the processing section which detects the defective pixel in an image sensor 14 from the luminance signal Y inputted, respectively and a color-difference signal C. When the defective pixel detecting element 24 judges whether the pixel of a processing object is a defective pixel and detects a defective pixel from the variation of a luminance signal Y and a color-difference signal C, it outputs defective information.

[0025] The defective pixel detecting element 24 in this example judges whether they are whether the processing-object pixel is a defective pixel and a normal pixel value that is, with the pixel value of a processing-object pixel, and the circumference pixel value which approaches a processing-object pixel and exists on the outskirts. As shown in drawing 7 in detail, the defective pixel detecting element 24 the circumference pixel acquisition processing section 700 which acquires the surrounding pixel value of a processing-object pixel in case it judges whether the present pixel is a defective pixel The object pixel acquisition processing section 702 which acquires the pixel value of a processing-object pixel The judgment processing section 704 which judges whether a processing-object pixel is a defective pixel Judgment processing section 704 The setting processing section 706 which sets the threshold for judging as adjustable It contains. Judgment processing section 704 The equalization processing section 708 which equalizes the pixel value of a circumference pixel further The data-processing section 710 which computes the correlation of the circumference pixel value and the pixel value of an object pixel which were equalized Data-processing section 710 The comparison processing section 712 which outputs the comparison result which shows whether the result of an operation and the threshold which can be set are compared, and it judges with a processing-object pixel being the pixel value of a defect It contains.

[0026] Circumference pixel income processing section 700 A detection field is prepared around a processing-object pixel, and it has the function which carries out temporary storage maintenance of those pixel values. The circumference pixel income processing section 700 in this example As shown in drawing 8 , it is the object pixel 800. 5x5 pixel field 802 of every direction made into a core Each pixel value is memorized, respectively. Not only this but the circumference pixel income processing section 700 As shown in drawing 9 , it is the object pixel 900. Surrounding 3x3-pixel field 902 It is good to acquire the pixel value of the detection field where the above every direction consists of numbers of pixels of odd pieces, respectively. This detection area size is good also as a still larger field according to the resolution expected the total number of pixels of an image sensor 14. since 3 pixels of a perpendicular direction are used in this example in case YC signal is generated -- moreover, the number [ equal to it for detection of a pixel defect ] of pixels in every direction -- or the detection field of the larger number of pixels than it is set up.

[0027] It returns to drawing 7 and is the circumference pixel acquisition processing section 700. It is the judgment processing section 704 about the pixel value of a circumference pixel. Equalization processing section 708 It supplies. Moreover, the circumference pixel income processing section 700 It is the object pixel acquisition processing section 702 about a processing-object pixel. It supplies and is the object pixel acquisition processing section 702. It stores temporarily in order to take the output timing of the pixel value, and it is the judgment processing section 704. Data-processing section 710 It supplies. Equalization processing section 708 It is the processing section which computes the average of the circumference pixel value inputted, and the pixel value average except the processing-object pixel of the center in a detection field is computed.

[0028] Data-processing section 710 Equalization processing section 708 It is the processing section which computes the difference and its absolute value of the computed pixel value average and the pixel value of the object pixel supplied, and computes whenever [ correlation / of \*\* values ]. Therefore, in this example, whenever [ correlation ] will be high, so that whenever [ correlation ] is conversely small so that a calculation result is large low. When whenever [ correlation ] is high, even if the pixel value of an object pixel of

correlation with a circumference pixel is high, an object pixel is a defective pixel and that is not right, it is the pixel value which is not conspicuous as a crack. Conversely, when whenever [ correlation ] is low, correlation with a circumference pixel has the low pixel value of an object pixel, for example, it is in the crack condition which is conspicuous as the luminescent spot or scotoma.

[0029] whenever [ correlation / which was computed ] -- the comparison processing section 712 it sends -- having -- the comparison processing section 712 Whenever [ correlation ], and the setting processing section 706 from -- by comparing the threshold supplied, the comparison test of whether it is within the limits had and permitted [ width of face / a certain ] in whenever [ correlation ] is carried out. Comparison processing section 712 Comparison output 714 The output of the defective pixel detecting element 24 is constituted, and it connects with the defective amendment processing section 26. thus, in this example, it serves, and it suits, and a defective judging is come out and carried out and the defective information for amending this to the pixel of a state of impairment which is accepted as a crack of the pixel state of impairment and image pick-up picture signal in an image sensor 14 which is conspicuous on an image pick-up image is generated. In addition, in advance of actual photography, use an opaque white color plate, a lens cover, etc., and the black crack and white crack in bright state and a dark condition are detected, respectively. Memorize these crack location and by the case where subsequent defective amendment is performed, based on the positional information For example, even if the white crack has occurred to bright state, it does not amend according to the level, and conversely, though the black crack has occurred to a dark condition, it is not necessary to amend depending on the crack level.

[0030] Moreover, a pixel defect may be judged using a luminance signal Y, and a defective judging may be carried out, respectively, using separately a luminance signal Y and a color-difference signal C, and you may judge further whether it is a defective pixel about an object pixel from both judgment result. According to the compress mode and image size at the time of carrying out compression coding of the image data, the others 10, for example, the camera, in the case of carrying out a manual setup, a change may be made possible or this threshold that sets defective judging level as adjustable may change a threshold according to the class of color filter put on the pixel judged that is a defective pixel. Moreover, it is good to make a threshold differ by the time of the dynamic-image image pick-up mode in a camera 10, and the photography recording mode which records a static image on a memory card 16.

[0031] Moreover, it is based on the pixel value average of a circumference pixel and object pixel in a detection field. In case a defective judging is carried out, it is the above-mentioned data-processing section 710. And the comparison processing section 712 It replaces with a configuration. The upper limit and lower limit of predetermined width of face are set as a pixel value average, the comparison test of whether the pixel value of an object pixel exceeds a upper limit is carried out, the comparison test of whether it is under a lower limit is carried out further, and you may make it judge whether the pixel value of an object pixel is within the limits of these threshold value. In this case, the setting processing section 706 These upper limits and a lower limit are set up.

[0032] Thus, the defective pixel detecting element 24 is not only this but the digital camera 800 shown, for example in drawing 12 in the case where the location of a defective pixel has become clear beforehand, although it is constituted based on the image data after YC conversion so that a defective pixel may be detected. Like the example of a configuration, it is the defective amendment section 802,804 about the position coordinate. You may supply, respectively. this example -- the output of YC processing section 18 -- each low pass filter (LPF) -- 806,808 inputting -- LPF 806,808 pixel value amendment of as opposed to a defective pixel to an output -- each defective amendment section 802,804 It is constituted so that it may carry out. Defective amendment section 802,804 Defective pixel amendment control section 810 According to the defective information supplied, interpolation processing of the pixel value of a processing-object pixel is carried out with the pixel value of the contiguity pixel. Amendment control section 810 It is memory 812. The defective information according to the positional information memorized is generated, and it is each defective amendment section 802,804. It outputs.

[0033] Moreover, the defective amendment processing by such position-coordinate storage and the defective pixel detection processing in the example shown in drawing 1 are combined, and it is memory 812. It is good to detect the abnormality pixel value of the pixel location which is not in the memorized position coordinate, and to make it amend. Moreover, when YC image data is memorized in the frame memory etc., you may make it the

defective pixel detecting element 24 output the memory address in the storage region etc.

[0034] Returning to drawing 1, the defective amendment processing section 26 is the pixel value amendment processing section which carries out interpolation processing of the pixel value judged to be a defective pixel by the contiguity pixel. The defective amendment processing section 26 in this example carries out interpolation processing of the pixel value by the contiguity pixel to a luminance signal Y and a color-difference signal C following the defective information supplied from the defective pixel detecting element 24, and outputs the pixel value interpolated while outputting the normal pixel as it was.

[0035] The defective amendment processing section 26 in this example performs interpolation processing which uses two pixel values after 1 pixel 1 pixel before continuing horizontally to the present pixel, as the pixel 1000 of drawing 10 shows, for example, replaces these averages as a pixel value of an object pixel. In this case, interpolation processing which replaces the pixel value of the present pixel with any one pixel value may be performed.

[0036] Moreover, the defective amendment processing section 26 uses the front Rhine pixel and/or back Rhine pixel which continue perpendicularly, it may be constituted so that the pixel value of the present pixel may be interpolated, and you may make it amend the present pixel value further to the present pixel, using the 4-pixel value which adjoins vertically and horizontally, as the pixel 1004 of drawing 10 shows as the pixel 1002 of drawing 10 shows. Moreover, although illustration has not been carried out, the pixel value which adjoins in the direction of slant to the present pixel is used, and you may make it amend the present pixel value. About the pixel used for these amendment processing, YC pixel of the contiguity pixel used as 1 pixel can be used for the array of a color filter, without depending. In the example shown by drawing 10, although it was a pixel location to the pixel on which G filter was put also as the basis, as shown, for example in drawing 11, the pixel value of either of the contiguity pixels which adjoin an object pixel or any or plurality, and the pixel use all the contiguity pixels further and corresponding to defective information can be amended also about the pixel of the location corresponding to other filter colors.

[0037] About the pixel used for these amendments, it is good to ask for whenever [ with a processing-object pixel / correlation ] independently for every pixel of each pixel circumference, and to, amend the object pixel according to defective information for example, using the higher contiguity pixel of whenever [ correlation ]. Moreover, you may make it set up according to the class of color filter currently used for the pixel from the first, so that the above-mentioned threshold may be differed.

[0038] output 110,112 of the defective pixel amendment processing section 26 a low pass filter (LPF) -- 28 and 30 it connects, respectively -- having -- LPF 28 and 30 It is the digital filter which the high-frequency component of image data is filtered [ digital filter ] and passes an inside low-pass component. LPF 28 and 30 They are the luminance signal Y and color-difference signals Cr and Cb which were normally processed from the output. It is outputted. LPF 28 and 30 Each output 114,116 It connects with the compression processing section 32, respectively, and the compression processing section 32 is picturized following the depression of for example, release \*\*, and carries out compression coding of the image data by which defective amendment was carried out.

[0039] The compression processing section 32 in this example is based on the still picture compression method based on a JPEG method, and is a luminance signal Y and color-difference signals Cr and Cb. It is DCT about each the block of each, respectively. It changes and quantizes. The compression processing section 32 is omitted according to the compressibility which has the multiplier of the quantized data set up, and carries out Huffman coding to the information which remains. The compression processing section 32 is a card interface (I/F) about the image data which carried out in this way and was encoded. It outputs to a circuit 34 and an interface circuitry 34 writes the image data and the various attached information which were encoded in the record section in the record format which suits the memory card 16 which can be detached and attached freely. The memory card 16 in this example is equipped with semiconductor memory, such as EEPROM and a flash memory, memorizes coded data etc. to a predetermined storage region according to the command from a circuit 34, and reads the memorized data and outputs them to a circuit 34. Moreover, it replaces with a memory card 16 and the information record medium which records information with light and/or the MAG may be used.

[0040] A system controller 40 is a control circuit by the microcomputer which controls each part of a camera 10 and performs image pick-up and record control, and its circumference circuit. A system controller 40 may perform the various operations and comparison processing which are performed by the interpolation processing

in the defective amendment processing section 26 mentioned above, and the detection processing in the defective pixel detecting element 24 in the procedure by software, and when performing a defect in that case, the program which realizes the processing facility shown in drawing 7 is loaded to a controller 40.

[0041] Moreover, to YC image data recorded on the above information storages, the defective pixel detecting element 24 and the defective amendment processing section 26 can judge the defective pixel at the time of the image pick-up of the image data, and can also amend the pixel value. This is effective at the case where record for example, an image pick-up signal on an information record medium by no compressing, and various picture signal processings are performed at the time of the playback etc. With the camera in this case, since a processing load is reduced without performing defective pixel amendment processing, when picturizing, for example by the high pixel consistency, the time amount which other picture signal processings take can be increased, or photography spacing can be shortened.

[0042] As explained above, since YC picture signal processed in YC processing section 18 is inputted and the pixel value of the object pixel according to defective information is interpolated by the contiguity pixel, a defective pixel can be amended in the defective amendment processing section 26, without being based on the filter array of an image sensor 14. Moreover, in the defective pixel detecting element 24, YC picture signal is inputted similarly, the amount of pixel value changes to the circumference pixel of a processing-object pixel is detected based on each pixel value in the detection field to YC picture signal, and the pixel which is conspicuous as a crack and appears by the image pick-up image can be detected.

[0043] Moreover, in case YC conversion of the output of a color image sensor is carried out, YC picture signal is generated using a 3 pixels long pixel value, and when the detection field which covers it is prepared, good amendment processing is performed, without being influenced in the case of defective amendment of the defective pixel derived in the pixel used in the case of YC conversion.

[0044] Thus, the pixel determined as a crack can be amended in the above-mentioned example, without performing interpolation processing by the pixel with a big distance between pixels, without being based on a filter array, since detection and amendment processing of a defective pixel are performed to YC picture signal. In this case, it is not necessary to perform interpolation processing which is needed since there are no components other than the opening pixel in an image sensor, i.e., the color component filter in a predetermined pixel location, in that pixel location. For this reason, it is not necessary to hold the pixel according to the array of a color filter, and increase of a circuit scale can be avoided in the case of defective detection and amendment. moreover, to a defective pixel which is not conspicuous as a crack, it may not need to be alike to that extent, it may be necessary to respond and amend about an image pick-up image, and a processing load is mitigated also in this case.

[0045] Moreover, although it is appropriate to process to brightness and a color-difference signal, in view of the compression effectiveness in case picture compression coding is carried out, it is possible for it to be incompressible, and to detect the pixel defect at the time of their being picturized also to YC image data recorded on the information record medium also as opposed to YC picture signal which processed such and was recorded on the information record medium, or to amend.

[0046]

[Effect of the Invention] Thus, according to this invention, since the defective pixel is amended to the picture signal of the format of a luminance signal and a color-difference signal, the defective pixel which can avoid increase of a circuit scale or a processing load, and is conspicuous as a crack is detectable good.

[0047] Moreover, since such processing can be performed \*\* [ according to / the color filter array of an image sensor ], detection / amendment processing of a defective pixel can be performed simply and correctly, and improvement in a result and image quality can be brought about. Thus, without a circuit scale increasing according to the color filter put on an image sensor, a defective pixel can be amended, and it is stabilized and a defective pixel can be detected.

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[Translation done.]

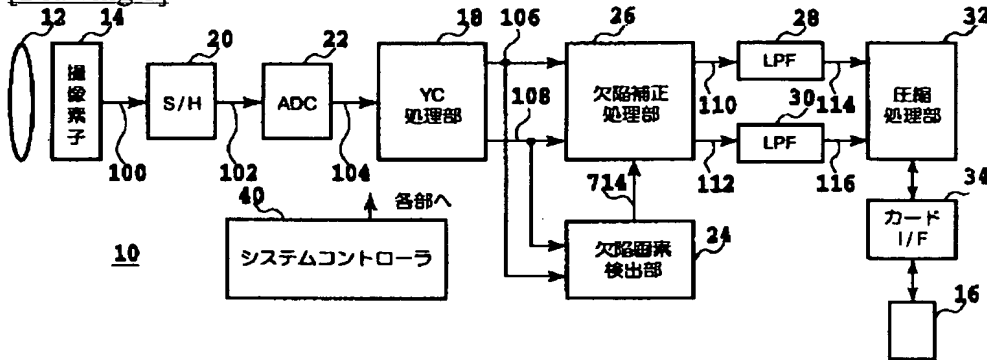
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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

## DRAWINGS

[Drawing 1]



[Drawing 2]

G R G B G R G B G  
 G B G R G B G R G  
 G R G B G R G B G  
 G B G R G B G R G  
 G R G B G R G B G  
 G B G R G B G R G  
 G R G B G R G B G  
 G B G R G B G R G

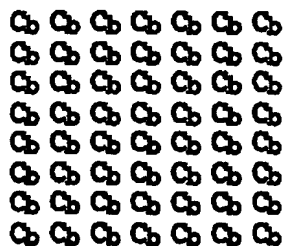
[Drawing 3]

Y Y Y Y Y Y Y Y  
 Y Y Y Y Y Y Y Y  
 Y Y Y Y Y Y Y Y  
 Y Y Y Y Y Y Y Y  
 Y Y Y Y Y Y Y Y  
 Y Y Y Y Y Y Y Y  
 Y Y Y Y Y Y Y Y  
 Y Y Y Y Y Y Y Y

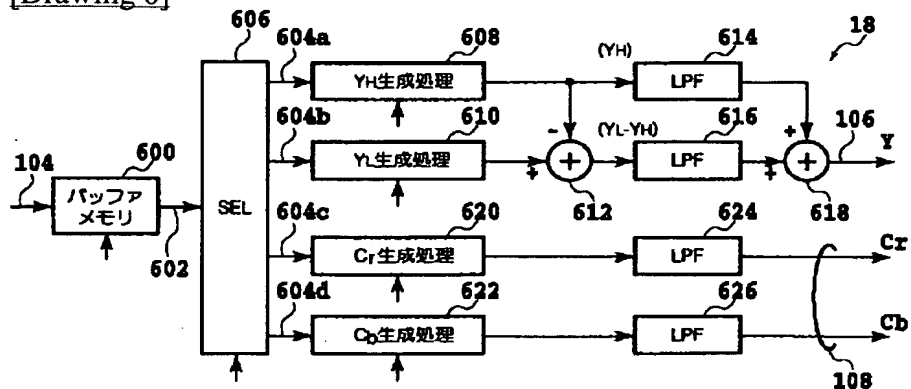
[Drawing 4]

C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>  
 C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>  
 C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>  
 C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>  
 C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>  
 C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>  
 C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>  
 C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub> C<sub>r</sub>

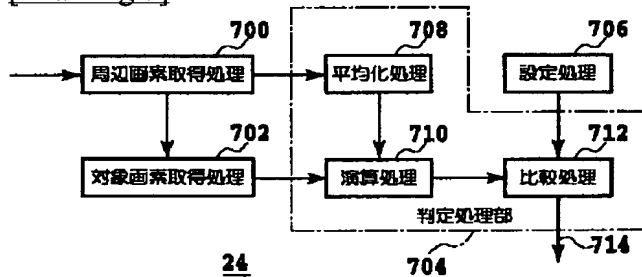
[Drawing 5]



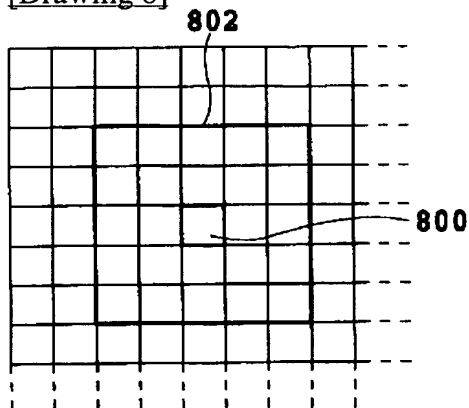
[Drawing 6]



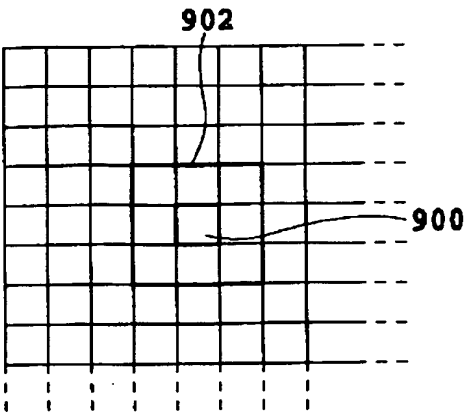
[Drawing 7]



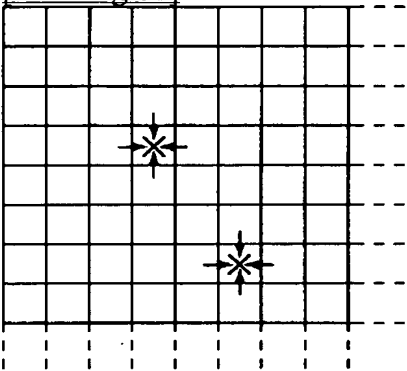
[Drawing 8]



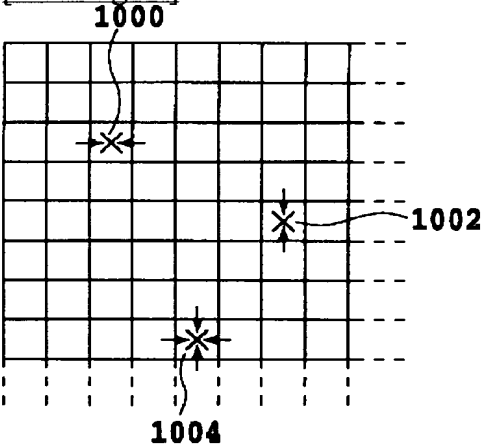
[Drawing 9]



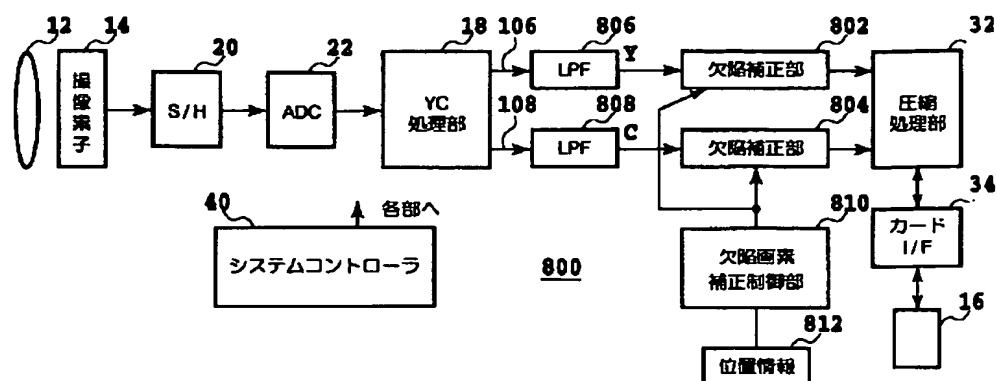
[Drawing 11]



[Drawing 10]



[Drawing 12]



[Translation done.]

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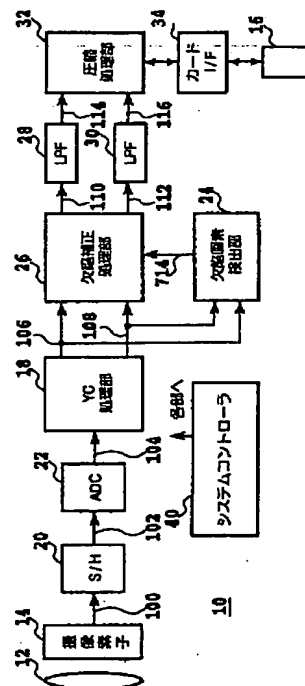
EE06 EE10 GG05 GG17 GG30

(54) 【発明の名称】 画素欠陥補正装置および画素欠陥検出装置ならびに方法

(57)【要約】

【課題】 撮像素子の有する色フィルタに応じて、回路規模が増大することなく、欠陥画素を補正でき、また、欠陥画素を安定して検出することのできる画素欠陥補正装置および画素欠陥検出装置ならびに方法を提供。

【解決手段】 欠陥画素検出部24および欠陥補正処理部26には、それぞれYC変換処理部にて処理されたYC画像信号が入力され、撮像素子14にて撮像された撮像画像における欠陥画素が、その周辺画素の画素値に基づいて欠陥画素検出部24にて検出され、その検出に応じた欠陥情報に基づいてその欠陥画素の画素値が欠陥補正処理部26にて補正される。



## 【特許請求の範囲】

【請求項1】 色フィルタが被着された撮像素子から出力される画素信号を入力し、該撮像素子における欠陥画素による画素信号を補正する画素欠陥補正装置において、該装置は、

前記画素信号が輝度成分および色差成分に変換された画像信号を入力する入力手段と、

前記欠陥画素の位置に応じた欠陥情報を出力する欠陥情報出力手段と、

前記入力手段に入力される画像信号における欠陥画素を補正する欠陥補正手段とを含み、

前記欠陥補正手段は、前記欠陥情報に応じた画素の画素値を、該画素の隣接画素の画素値で補正して出力することを特徴とする画素欠陥補正装置。

【請求項2】 請求項1に記載の補正装置において、前記欠陥補正手段は、前記欠陥情報に応じた画素の画素値を、前記輝度成分および前記色差成分の画像信号の画素値で補正することを特徴とする画素欠陥補正装置。

【請求項3】 請求項1に記載の補正装置において、該装置は、前記画素信号を輝度成分および色差成分に変換して前記画像信号を出力する変換手段を含み、前記入力手段は、該変換手段にて変換された画像信号を入力することを特徴とする画素欠陥補正装置。

【請求項4】 請求項3に記載の補正装置において、前記変換手段は、前記画像信号における画素に垂直方向に隣接する画素を用いて該画像信号の高域成分および低域成分を生成し、これら高域および低域成分から前記輝度成分の輝度信号を生成し、さらに前記処理対象画素に垂直方向に隣接する画素を用いて該画像信号の色差成分の色差信号を生成し、

前記欠陥補正手段は、前記輝度信号および色差信号を補正することを特徴とする画素欠陥補正装置。

【請求項5】 請求項1に記載の補正装置において、前記欠陥情報出力手段は、前記画像信号の変化量を検出する検出手段を含み、該検出手段の検出結果に応じた欠陥情報を前記欠陥補正手段に供給することを特徴とする画素欠陥補正装置。

【請求項6】 請求項5に記載の補正装置において、前記検出手段は、対象画素周辺の画素値を取得する第1の取得手段と、前記対象画素の画素値を取得する第2の取得手段と、第1および第2の取得手段にて取得したそれぞれの画素値に基づいて、前記対象画素を欠陥画素として決定するか否かを判定する判定手段とを含み、該判定手段は、該判定結果に応じた欠陥情報を前記欠陥補正手段に出力することを特徴とする画素欠陥補正装置。

【請求項7】 請求項6に記載の補正装置において、前記判定手段は、前記第1の取得手段にて取得された画素値を平均化して画素値平均を算出する平均化手段と、前記対象画素の画素値と、前記画素値平均とを比較する比

較手段とを含み、該比較結果に応じた欠陥情報を前記欠陥補正手段に出力することを特徴とする画素欠陥補正装置。

【請求項8】 請求項7に記載の補正装置において、前記比較手段は、前記対象画素の画素値が、前記画素値平均の所定の範囲内にあるか否かを比較判定することを特徴とする画素欠陥補正装置。

【請求項9】 請求項8に記載の補正装置において、前記比較手段は、前記画素値平均と前記対象画素の画素値との差分絶対値を算出する演算手段を含み、該差分絶対値が前記所定の範囲内にあるか否かを比較判定することを特徴とする画素欠陥補正装置。

【請求項10】 請求項8または9に記載の補正装置において、該装置は、前記所定の範囲を可変に設定する設定手段を含むことを特徴とする画素欠陥補正装置。

【請求項11】 請求項7に記載の補正装置において、前記平均化手段は、前記対象画素を中心とする周辺の縦横 $m \times n$ 画素( $m, n$ は3以上の奇数)の画素のうち、該対象画素を除く領域の画素値平均を算出することを特徴とする画素欠陥補正装置。

【請求項12】 請求項11に記載の補正装置において、前記平均化手段は、前記対象画素を除く領域の縦横 $5 \times 5$ 画素の画素値平均を算出することを特徴とする画素欠陥補正装置。

【請求項13】 請求項5に記載の補正装置において、該装置は、前記欠陥補正手段の出力に低域通過型フィルタ手段が接続されることを特徴とする画素欠陥補正装置。

【請求項14】 請求項1に記載の補正装置において、前記位置情報出力手段は、前記撮像素子の欠陥画素を検査した結果、欠陥画素と判定された欠陥情報として、該欠陥画素の位置を表す位置情報を予め記憶する記憶手段を含み、

前記欠陥補正手段は、前記位置情報に応じた画素の画素値を補正することを特徴とする画素欠陥補正装置。

【請求項15】 請求項14に記載の補正装置において、該装置は、前記変換手段の出力に低域通過型フィルタ手段が接続され、

前記欠陥補正手段は、該低域通過型フィルタ手段から出力される画像信号について前記欠陥画素の補正処理を行うことを特徴とする画素欠陥補正装置。

【請求項16】 請求項1に記載の補正装置において、前記欠陥補正手段は、欠陥補正対象画素の前および/または後の隣接画素値で、前記対象画素の画素値を補間することを特徴とする画素欠陥補正装置。

【請求項17】 請求項1に記載の補正装置において、前記欠陥補正手段は、欠陥補正対象画素の前ラインおよび/または後ラインの画素値で、前記対象画素の画素値を補間することを特徴とする画素欠陥補正装置。

【請求項18】 請求項1に記載の補正装置において、

前記欠陥補正手段は、補正対象画素の画素位置が前記撮像素子における撮像セルに被着された色フィルタの色成分に応じて、補正方法を選択することを特徴とする画素欠陥補正装置。

【請求項19】 請求項3に記載の補正装置において、前記色フィルタは、RGB原色カラーフィルタであり、前記変換手段は、前記撮像素子から出力されるRGB画素信号から前記画像信号を生成することを特徴とする画素欠陥補正装置。

【請求項20】 請求項19に記載の補正装置において、前記RGB原色カラーフィルタは、Gストライプ配列で、R、Bを市松状に配列したカラーフィルタであることを特徴とする画素欠陥補正装置。

【請求項21】 請求項3に記載の補正装置において、前記色フィルタは、補色カラーフィルタであり、前記変換手段は、前記撮像素子から出力される補色信号から前記画像信号を生成することを特徴とする画素欠陥補正装置。

【請求項22】 請求項1に記載の補正装置において、該装置は、前記撮像素子を含むことを特徴とする欠陥画素補正装置。

【請求項23】 請求項1に記載の補正装置において、該装置は、前記欠陥補正手段から出力される画像信号を処理して情報記憶媒体に記録する記録手段を含むことを特徴とする欠陥画素補正装置。

【請求項24】 色フィルタが被着された撮像素子から出力される画素信号を入力し、該撮像素子における欠陥画素による画素信号を検出する画素欠陥検出装置において、該装置は、前記画素信号が輝度成分および色差成分に変換された画像信号を入力する入力手段と、

前記画像信号の変化量を検出する検出手段とを含み、該検出手段は、

前記対象画素周辺の画素値を取得する第1の取得手段と、

前記対象画素の画素値を取得する第2の取得手段と、第1および第2の取得手段にて取得したそれぞれの画素値に基づいて、前記対象画素が欠陥画素として決定するかどうかを判定する判定手段とを含み、該判定手段は、該判定結果を出力することを特徴とする画素欠陥検出装置。

【請求項25】 請求項24に記載の検出装置において、前記判定手段は、前記第1の取得手段にて取得された画素値を平均化して画素値平均を算出する平均化手段と、前記対象画素の画素値と、前記画素値平均とを比較する比較手段とを含み、該比較結果に応じた前記判定結果を出力することを特徴とする画素欠陥検出装置。

【請求項26】 請求項25に記載の検出装置において、前記比較手段は、前記対象画素の画素値が、前記画素値平均の所定の範囲内にあるかどうかを比較判定するこ

とを特徴とする画素欠陥検出装置。

【請求項27】 請求項26に記載の検出装置において、前記比較手段は、前記画素値平均と前記対象画素の画素値との差分絶対値を算出する演算手段を含み、該差分絶対値が前記所定の範囲内にあるかどうかを比較判定することを特徴とする画素欠陥検出装置。

【請求項28】 請求項26または27に記載の検出装置において、該装置は、前記所定の範囲を可変に設定する設定手段を含むことを特徴とする画素欠陥検出装置。

【請求項29】 請求項25に記載の検出装置において、前記平均化手段は、前記対象画素を中心とする周辺の縦横 $m \times n$ 画素( $m, n$ は3以上の奇数)の画素のうち、該対象画素を除く領域の画素値平均を算出することを特徴とする画素欠陥検出装置。

【請求項30】 請求項29に記載の検出装置において、前記平均化手段は、前記対象画素を除く領域の縦横 $5 \times 5$ 画素の画素値平均を算出することを特徴とする画素欠陥検出装置。

【請求項31】 請求項24に記載の検出装置において、該装置は、前記画素信号を輝度成分および色差成分に変換して前記画像信号を出力する変換手段を含み、前記入力手段は、該変換手段にて変換された画像信号を入力することを特徴とする画素欠陥検出装置。

【請求項32】 請求項31に記載の検出装置において、前記変換手段は、前記画素信号における画素に垂直方向に隣接する画素を用いて該画素信号の高域成分および低域成分を生成し、これら高域および低域成分から前記輝度成分の輝度信号を生成し、さらに前記処理対象画素に垂直方向に隣接する画素を用いて該画素信号の色差成分の色差信号を生成することを特徴とする画素欠陥検出装置。

【請求項33】 色フィルタが被着された撮像素子から出力される画素信号を入力し、該撮像素子における欠陥画素による画素信号を補正する画素欠陥補正方法において、該方法は、前記画素信号が輝度成分および色差成分に変換された画像信号を入力する入力工程と、前記欠陥画素の位置に応じた欠陥情報を出力する欠陥情報出力工程と、

前記入力工程にて入力される画像信号における欠陥画素を補正する欠陥補正工程とを含み、

前記欠陥補正工程は、前記欠陥情報に応じた画素の画素値を、該画素の隣接画素の画素値で補正することを特徴とする画素欠陥補正方法。

【請求項34】 請求項33に記載の補正方法において、前記欠陥補正工程は、前記欠陥情報に応じた画素の画素値を、前記輝度成分および前記色差成分の画像信号の画素値で補正することを特徴とする画素欠陥補正方法。

【請求項35】 請求項33に記載の補正方法において

て、該方法は、前記画素信号を輝度成分および色差成分に変換して前記画像信号を出力する変換工程を含み、前記入力工程は、該変換工程にて変換された画像信号を入力することを特徴とする画素欠陥補正方法。

【請求項36】 請求項35に記載の補正方法において、前記変換工程は、前記画像信号における画素に垂直方向に隣接する画素を用いて該画像信号の高域成分および低域成分を生成し、これら高域および低域成分から前記輝度成分の輝度信号を生成し、さらに前記処理対象画素に垂直方向に隣接する画素を用いて該画像信号の色差成分の色差信号を生成し、前記欠陥補正工程は、前記輝度信号および色差信号を補正することを特徴とする画素欠陥補正方法。

【請求項37】 請求項33に記載の補正方法において、前記欠陥情報出力工程は、前記画像信号の変化量を検出する検出工程を含み、該検出工程での検出結果に応じた欠陥情報を生成することを特徴とする画素欠陥補正方法。

【請求項38】 請求項37に記載の補正方法において、前記検出工程は、前記対象画素周辺の画素値を取得する第1の取得工程と、前記対象画素の画素値を取得する第2の取得工程と、第1および第2の取得工程にて取得したそれぞれの画素値に基づいて、前記対象画素を欠陥画素として決定するか否かを判定する判定工程とを含み、該判定工程は、該判定結果に応じた欠陥情報を生成することを特徴とする画素欠陥補正方法。

【請求項39】 請求項38に記載の補正方法において、前記判定工程は、前記第1の取得手段にて取得された画素値を平均化して画素値平均を算出する平均化工程と、前記対象画素の画素値と、前記画素値平均とを比較する比較工程とを含み、該比較結果に応じた欠陥情報を生成することを特徴とする画素欠陥補正方法。

【請求項40】 請求項39に記載の補正方法において、前記比較工程は、前記対象画素の画素値が、前記画素値平均の所定の範囲内にあるか否かを比較判定することを特徴とする画素欠陥補正方法。

【請求項41】 請求項40に記載の補正方法において、前記比較工程は、前記画素値平均と前記対象画素の画素値との差分絶対値を算出する演算工程を含み、該差分絶対値が前記所定の範囲内にあるか否かを比較判定することを特徴とする画素欠陥補正装置。

【請求項42】 請求項40または41に記載の補正方法において、該方法は、前記所定の範囲を可変に設定する設定工程を含むことを特徴とする画素欠陥補正方法。

【請求項43】 請求項39に記載の補正方法において、前記平均化工程は、前記対象画素を中心とする周辺の縦横 $m \times n$ 画素( $m, n$ は3以上の奇数)の画素のうち、該対象画素を除く領域の画素値平均を算出すること

を特徴とする画素欠陥補正方法。

【請求項44】 請求項43に記載の補正方法において、前記平均化工程は、前記対象画素を除く領域の縦横 $5 \times 5$ 画素の画素値平均を算出することを特徴とする画素欠陥補正装置。

【請求項45】 請求項37に記載の補正方法において、該方法は、前記欠陥補正工程にて補正された画像信号に対して低域通過型フィルタ処理を行うことを特徴とする画素欠陥補正方法。

【請求項46】 請求項33に記載の補正方法において、前記位置情報出力工程は、前記撮像素子の欠陥画素を検査した結果、欠陥画素と判定された欠陥情報として、該欠陥画素の位置を表す位置情報を予め記憶する記憶工程を含み、

前記欠陥補正工程は、前記位置情報に応じた画素の画素値を補正することを特徴とする画素欠陥補正方法。

【請求項47】 請求項46に記載の補正方法において、該方法は、前記変換工程にて補正された画像信号に対して低域通過型フィルタ処理を行い、前記欠陥補正工程は、該低域通過型フィルタ処理された画像信号について前記欠陥画素の補正処理を行うことを特徴とする画素欠陥補正方法。

【請求項48】 請求項33に記載の補正方法において、前記欠陥補正工程は、欠陥補正対象画素の前および/または後の隣接画素値で、前記対象画素の画素値を補間することを特徴とする画素欠陥補正方法。

【請求項49】 請求項33に記載の補正方法において、前記欠陥補正工程は、欠陥補正対象画素の前ラインおよび/または後ラインの画素値で、前記対象画素の画素値を補間することを特徴とする画素欠陥補正方法。

【請求項50】 請求項33に記載の補正方法において、前記欠陥補正工程は、補正対象画素の画素位置が前記撮像素子における撮像セルに被着された色フィルタの色成分に応じて、補正方法を選択することを特徴とする画素欠陥補正方法。

【請求項51】 請求項35に記載の補正方法において、前記色フィルタは、RGB原色カラーフィルタである場合に、前記変換工程は、前記撮像素子から出力されるRGB画素信号から前記画像信号を生成することを特徴とする画素欠陥補正方法。

【請求項52】 請求項51に記載の補正方法において、前記RGB原色カラーフィルタは、Gストライプ配列で、RBを市松状に配列したカラーフィルタであることを特徴とする画素欠陥補正方法。

【請求項53】 請求項35に記載の補正方法において、前記色フィルタは、補色カラーフィルタである場合に、前記変換工程は、前記撮像素子から出力される補色信号から前記画像信号を生成することを特徴とする画素欠陥補正方法。

【請求項54】 請求項33に記載の補正方法において

て、該方法は、前記欠陥補正工程にて補正された画像信号を処理して情報記憶媒体に記録する記録工程を含むことを特徴とする欠陥画素補正方法。

【請求項55】 色フィルタが被着された撮像素子から出力される画素信号を入力し、該撮像素子における欠陥画素による画素信号を検出する画素欠陥検出方法において、該方法は、

前記画素信号が輝度成分および色差成分に変換された画像信号を入力する入力工程と、

前記画像信号の変化量を検出する検出工程とを含み、該検出工程は、

前記対象画素周辺の画素値を取得する第1の取得工程と、

前記対象画素の画素値を取得する第2の取得工程と、第1および第2の取得工程にて取得したそれぞれの画素値に基づいて、前記対象画素が欠陥画素として決定するか否かを判定する判定工程とを含み、該判定工程は、該判定結果を出力することを特徴とする画素欠陥検出方法。

【請求項56】 請求項55に記載の検出方法において、前記判定工程は、前記第1の取得手段にて取得された画素値を平均化して画素値平均を算出する平均化工程と、前記対象画素の画素値と、前記画素値平均とを比較する比較工程とを含み、該比較結果に応じた前記判定結果を出力することを特徴とする画素欠陥検出方法。

【請求項57】 請求項56に記載の検出方法において、前記比較工程は、前記対象画素の画素値が、前記画素値平均の所定の範囲内にあるか否かを比較判定することを特徴とする画素欠陥検出方法。

【請求項58】 請求項57に記載の検出方法において、前記比較工程は、前記画素値平均と前記対象画素の画素値との差分絶対値を算出する演算工程を含み、該差分絶対値が前記所定の範囲内にあるか否かを比較判定することを特徴とする画素欠陥検出方法。

【請求項59】 請求項57または58に記載の検出方法において、該方法は、前記所定の範囲を可変に設定する設定工程を含むことを特徴とする画素欠陥検出方法。

【請求項60】 請求項56に記載の検出方法において、前記平均化工程は、前記対象画素を中心とする周辺の縦横 $m \times n$ 画素( $m, n$ は3以上の奇数)の画素のうち、該対象画素を除く領域の画素値平均を算出することを特徴とする画素欠陥検出方法。

【請求項61】 請求項60に記載の検出方法において、前記平均化工程は、前記対象画素を除く領域の縦横 $5 \times 5$ 画素の画素値平均を算出することを特徴とする画素欠陥検出方法。

【請求項62】 請求項55に記載の検出方法において、該方法は、前記画素信号を輝度成分および色差成分に変換して前記画像信号を出力する変換工程を含み、前記入力工程は、該変換工程にて変換された画像信号を入

力することを特徴とする画素欠陥検出方法。

【請求項63】 請求項62に記載の検出方法において、前記変換工程は、前記画素信号における画素に垂直方向に隣接する画素を用いて該画素信号の高域成分および低域成分を生成し、これら高域および低域成分から前記輝度成分の輝度信号を生成し、さらに前記処理対象画素に垂直方向に隣接する画素を用いて該画素信号の色差成分の色差信号を生成することを特徴とする画素欠陥検出方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、色フィルタが被着された撮像素子から出力される画素信号を入力し、撮像素子における欠陥画素による画素信号を検出し、補正する画素欠陥補正装置および画素欠陥検出装置ならびに方法に係り、たとえば、原色フィルタがその撮像面に被着された固体撮像素子における画素欠陥を補正する画素欠陥補正装置および画素欠陥検出装置ならびに方法に関するものである。

【0002】

【従来の技術】近年、被写界を撮像して、その被写界画像および映像をデジタル化して、磁気テープや回転記録媒体、さらには半導体メモリに記録するデジタルカメラが普及してきている。このようなカメラには、CCD固体撮像素子やMOS型撮像素子が搭載され、その高画素密度化に対する要求が高まってきている。

【0003】たとえば、デジタルスチルカメラでは、百万画素以上の撮像セルを有する固体撮像素子が用いられるようになってきた。このような単板の撮像素子の各撮像セルには、カラー画像を形成するための各種色フィルタが搭載されている。

【0004】しかし、各撮像セルでは、種々の理由から受光量に応じた電荷が生成されない、いわゆるキズが発生する。このキズ状態のセル、つまり欠陥画素に対応する画素信号は、その画像が表示されたときに、状況に応じて目立ってしまい、せっかくの撮影画像の品質を落とす原因となっていた。

【0005】そこで、このようなカラー撮像素子を使用する場合、各種の欠陥画素の補正方式が開発および実用化されている。

【0006】たとえば、特開平6-30425号公報には、補色市松方式の色コーティングのカラーCCD撮像素子の出力をサンプルホールドしデジタル化した後欠陥補正し、欠陥補正されたCCD出力に各種の信号処理を施してビデオ出力を得る固体撮像装置が開示されていた。

【0007】また、特開平9-205586号公報には、欠陥画素に関する情報を不揮発性メモリに記憶しておき、CCD固体撮像素子の欠陥画素検出システムが開示されていた。この公報では、固体撮像素子と信号処理回路との間に、欠陥画素の検出とその補正を行うための欠陥画素

検出補正回路が設けられているものであった。

【0008】

【発明が解決しようとする課題】しかしながら、従来では、欠陥画素補正を信号処理の前に行っていたため、たとえば、ソフトウェアにて補正処理を行う場合には、信号処理に応じた制限時間内に補正できる画素数に制限されるという問題があった。

【0009】また、単板のカラー撮像素子では、特に色フィルタ配列に応じた少ない画素のRGB画素、つまり同色色フィルタ間で隣接している画素で補間処理する必要があり、このため、周りの画素を保持するラインメモリやレジスタ等が補正回路内に多く必要となって、補正回路が複雑化するという問題があった。つまり、欠陥画素を補正する際に、その補正対象画素の前、後の画素や上下ラインの同色隣接画素の色フィルタの画素を使用すると画素間距離が大きくなって、このような画素を記憶保持するためにラインメモリやレジスタ等の記憶回路を多く補正回路内に設ける必要があった。

【0010】本発明はこのような従来技術の欠点を解消し、撮像素子の有する色フィルタに応じて、回路規模が増大することなく、欠陥画素を補正でき、また、欠陥画素を安定して検出することのできる画素欠陥補正装置および画素欠陥検出装置ならびに方法を提供することを目的とする。

【0011】

【課題を解決するための手段】本発明は上述の課題を解決するために、色フィルタが被着された撮像素子から出力される画素信号を入力し、撮像素子における欠陥画素による画素信号を補正する画素欠陥補正装置において、この装置は、画素信号が輝度成分および色差成分に変換された画像信号を入力する入力手段と、欠陥画素の位置に応じた欠陥情報を出力する欠陥情報出力手段と、入力手段に入力される画像信号における欠陥画素を補正する欠陥補正手段とを含み、欠陥補正手段は、欠陥情報に応じた画素の画素値を、この画素の隣接画素の画素値で補正して出力することを特徴とする。

【0012】また、本発明は上述の課題を解決するために、色フィルタが被着された撮像素子から出力される画素信号を入力し、撮像素子における欠陥画素による画素信号を検出する画素欠陥検出装置において、この装置は、画素信号が輝度成分および色差成分に変換された画像信号を入力する入力手段と、画像信号の変化量を検出する検出手段とを含み、検出手段は、対象画素周辺の画素値を取得する第1の取得手段と、対象画素の画素値を取得する第2の取得手段と、第1および第2の取得手段にて取得したそれぞれの画素値に基づいて、対象画素が欠陥画素として決定するか否かを判定する判定手段とを含み、判定手段は、判定結果を出力することを特徴とする。

【0013】さらに、本発明は上述の課題を解決するた

めに、色フィルタが被着された撮像素子から出力される画素信号を入力し、撮像素子における欠陥画素による画素信号を補正する画素欠陥補正方法において、この方法は、画素信号が輝度成分および色差成分に変換された画像信号を入力する入力工程と、欠陥画素の位置に応じた欠陥情報を出力する欠陥情報出力工程と、入力工程にて入力される画像信号における欠陥画素を補正する欠陥補正工程とを含み、欠陥補正工程は、欠陥情報に応じた画素の画素値を、この画素の隣接画素の画素値で補正することを特徴とする。

【0014】また、本発明は上述の課題を解決するために、色フィルタが被着された撮像素子から出力される画素信号を入力し、撮像素子における欠陥画素による画素信号を検出する画素欠陥検出方法において、この方法は、画素信号が輝度成分および色差成分に変換された画像信号を入力する入力工程と、画像信号の変化量を検出する検出工程とを含み、検出工程は、対象画素周辺の画素値を取得する第1の取得工程と、対象画素の画素値を取得する第2の取得工程と、第1および第2の取得工程にて取得したそれぞれの画素値に基づいて、対象画素が欠陥画素として決定するか否かを判定する判定工程とを含み、判定工程は、判定結果を出力することを特徴とする。

【0015】

【発明の実施の形態】次に添付図面を参照して本発明による画素欠陥補正装置をデジタルカメラに適用した実施例を詳細に説明する。図1を参照すると、撮像レンズ12を介して結像される光学像を撮像素子14にて光電変換し、被写界像に応じたカラー画像信号を生成してメモリカード16等の情報記憶媒体に記憶させるデジタルカメラ10が示されている。このデジタルカメラ10は、YC処理部18の出力信号に対して欠陥画素の検出処理および補正処理を行うことにより、撮像素子14にて発生する欠陥画素を修正する機能を有する。なお、以下の説明において本発明に直接関係のない部分は、図示およびその説明を省略し、また、信号の参照符号はその現われる接続線の参照番号で表わす。

【0016】撮像素子14は、垂直および水平方向に複数の撮像セルが形成され、各セルのフォトダイオードに到達する光の量に応じた電荷を生成し、これを各セルに対応する複数の垂直電荷転送路と水平電荷転送路を介して読み出し、各セルの受光量に応じた画素値を表す画素信号として出力100に出力する固体撮像素子である。各セルの受光面には、撮像レンズ12からの光束を集光するマイクロレンズとカラー画像を生成するための分光特性が異なる色フィルタとが形成されており、本実施例では、図2に示すフィルタ配列の原色カラーフィルタが被着されて、それぞれ分光感度特性がR・G・B(赤・緑・青)ごとに異なる撮像セルが形成されている。このカラーフィルタは、垂直方向にGフィルタがストライプ状に

配列され、Gフィルタ列の間ごとにRB、BRの色フィルタ列が交互に配列されているGストライプRB完全市松配列のカラーフィルタである。

【0017】固体撮像素子には、一般に、その製造上の問題から、受光量に応じた電気信号を生成しない撮像セルが発生し、たとえば、受光量とは無関係に明るい状態の画素を示す白キズや暗い状態を示す黒キズなどが、その出力信号に含まれる。これらを完全になくすように選別すると歩留まりの低下につながる。そこで、そのキズ発生程度に応じて、撮像素子の出力信号に対して、そのキズ状態の撮像セルからの画素値を補正することが行われる。たとえば、特定のR画素が欠陥画素であるとする、その欠陥画素に対して、同一の色成分に着目して隣接する他のR画素の値を用いて、欠陥画素の画素値を補正することが行われていた。しかし、本実施例では、このような方法にはよらずに、画素信号100を変換して生成した輝度信号Yおよび色差信号CのYC画像信号に対して欠陥補正を行い、また、このようなYC画像信号で欠陥画素を検出するように構成されている。

【0018】撮像素子14の出力100には、フィルタ配列に応じた点順次のRGB画素信号が出力され、不図示の相關二重サンプリング回路を経てサンプル・ホールド回路20に入力される。ここで保持されたRGB点順次の画素信号102は、アナログ・デジタル変換(ADC)回路22にて、離散的なデジタル画像信号に変換される。

【0019】アナログ・デジタル変換(ADC)回路の出力104はYC処理部18に接続され、YC処理部18は、ADC回路22より出力されるRGB画素信号104を輝度信号Yおよび色差信号CのYC画像信号に変換する処理回路である。

【0020】本実施例におけるYC処理部18は、処理対象の画素に対して1つ前のラインにおける前ライン画素と、1つ後のラインにおける後ライン画素との垂直(縦)方向の上下に配置された3画素、もしくはそれに水平方向に隣接する3画素を加えた6画素を用いて、画像信号の高域成分YHと低域成分YLとを生成し、図3ないし図5に示すような輝度信号Yと、色差信号Cr,Cbとを生成する。

【0021】詳しくはYC処理部18は、図6に示すように、デジタル化されたRGB画素信号104を一時記憶するバッファメモリ600と、バッファメモリ600から読み出されるRGB画素信号602を選択して所望の出力604a,604b,604c,604dに出力する選択回路(SEL)606とを有している。その出力604aに接続されるYH生成処理部608と、出力604bに接続されるYL生成処理部610とは、入力される縦方向に分布する3画素値を用いて所定の演算方法により輝度信号の高域成分YHと低域成分YLとを算出する。YH生成処理部608の高域成分YH出力は、加算器612の一方の入力とローパスフィルタ(LPF)614とに接続され、YL生成処理部610の低域成分出力は加算器612の他

方の入力に接続されている。加算器612は、高域成分YHと低域成分YLとを合成して信号(YL-YH)を生成し、ローパスフィルタ(LPF)616に供給する。加算器618はそれぞれのLPF614,616にて処理された成分信号を(YL-YH)+YHという輝度信号の合成を行って、輝度信号Yを出力106に出力する。

【0022】選択回路606の出力604c,604dにそれぞれ接続されるCr生成処理部620およびCb生成処理部622は、同様に、垂直方向に分布する3画素値もしくは上述したような6画素値を用いて色差成分Cr,Cbを生成し、ローパスフィルタ(LPF)624,626はそれぞれこれら色差成分をフィルタ処理して色差信号C(Cr,Cb)を出力108に出力する。

【0023】このようにYC処理回路18は、RGB画素データから補間処理して各画素位置におけるRGB各画素値を算出してからYC処理を行うのではなく、隣接する少なくとも縦3画素から輝度および色差成分の各信号を生成する。YC処理回路18の出力106および108は、欠陥画素検出部24と欠陥補正処理部26とにそれぞれ接続されている。

【0024】欠陥画素検出部24は、入力106,108にそれぞれ入力される輝度信号Yと色差信号Cから、撮像素子14における欠陥画素を検出する処理部である。欠陥画素検出部24は、輝度信号Yおよび色差信号Cの変化量から、処理対象の画素が欠陥画素であるか否かを判定し、欠陥画素を検出した際に欠陥情報を出力する。

【0025】本実施例における欠陥画素検出部24は、処理対象画素の画素値と、処理対象画素に近接して周辺に存在する周辺画素値とにより、その処理対象画素が欠陥画素であるか否か、つまり正常な画素値であるかを判定する。詳しくは図7に示すように、欠陥画素検出部24は、現画素が欠陥画素であるか否かを判定する際に、処理対象画素の周辺の画素値を取得する周辺画素取得処理部700と、処理対象画素の画素値を取得する対象画素取得処理部702と、処理対象画素が欠陥画素であるか否かを判定する判定処理部704と、判定処理部704にて判定するための閾値を可変に設定する設定処理部706とを含む。判定処理部704は、さらに周辺画素の画素値を平均化する平均化処理部708と、平均化された周辺画素値と対象画素の画素値との相関関係を算出する演算処理部710と、演算処理部710における演算結果と閾値とを比較して、処理対象画素が欠陥の画素値であると判定するか否かを示す比較結果を出力する比較処理部712とを含む。

【0026】周辺画素所得処理部700は、処理対象画素周辺に検出領域を設け、それらの画素値を一時記憶保持する機能を有する。本実施例における周辺画素所得処理部700は、図8に示すように対象画素800を中心とする縦横5×5画素領域802の各画素値をそれぞれ記憶する。これに限らず周辺画素所得処理部700は、図9に示

すように、対象画素900周辺の3×3画素領域902以上の縦横がそれぞれ奇数個の画素数で構成される検出領域の画素値を取得するとよい。この検出領域の大きさは、撮像素子14の総画素数と希望する解像度とに応じてさらに大きい領域としてもよい。本実施例では、YC信号を生成する際に垂直方向の3画素を使用しているのも、また、画素欠陥の検出のためには、それと等しい縦横の画素数か、もしくはそれよりも大きな画素数の検出領域を設定する。

【0027】図7に戻って、周辺画素取得処理部700は、周辺画素の画素値を判定処理部704の平均化処理部708に供給する。また、周辺画素取得処理部700は、処理対象画素を対象画素取得処理部702に供給し、対象画素取得処理部702は、その画素値の出力タイミングを採るために一時記憶して、判定処理部704の演算処理部710に供給する。平均化処理部708は、入力される周辺画素値の平均を算出する処理部であり、検出領域における中央の処理対象画素を除く画素値平均を算出する。

【0028】演算処理部710は、平均化処理部708にて算出された画素値平均と、供給される対象画素の画素値との差およびその絶対値を算出し、こちら値の相関度を算出する処理部である。したがって本実施例では、算出結果が大きいほど相関度は低く、逆に小さいほど相関度が高いこととなる。相関度が高い場合には、対象画素の画素値は、周辺画素との相関が高く、対象画素が欠陥画素であってもそうではなくても、キズとしては目立たない画素値である。逆に相関度が低い場合には、対象画素の画素値が周辺画素との相関が低く、たとえば輝点や暗点として目立つキズ状態である。

【0029】算出された相関度は比較処理部712に送られ、比較処理部712は、その相関度と、設定処理部706から供給される閾値とを比較することにより、相関度がある幅を持って、許容される範囲内であるか否かを比較判定する。比較処理部712の比較出力714は、欠陥画素検出部24の出力を構成し、欠陥補正処理部26に接続されている。このように本実施例では、撮像素子14における画素欠陥状態と撮像画像信号とのかねあいで欠陥判定しており、撮像画像上で目立つようなキズとして認められるような欠陥状態の画素に対してこれを補正するための欠陥情報が生成される。なお、実際の撮影に先立って、乳白色板やレンズカバー等を使用し、明状態および暗状態における黒キズおよび白キズをそれぞれ検出して、それらキズ位置を記憶し、その位置情報に基づいて、その後の欠陥補正を行う場合などでは、たとえば明状態に対して白キズが発生していてもそのレベルに応じて補正せず、逆に、暗状態に対して黒キズが発生していたとしても、そのキズレベルによっては補正しなくてもよい。

【0030】また、輝度信号Yのみを使用して画素欠陥を判定してもよく、また、輝度信号Yと色差信号Cとを別々に用いてそれぞれ欠陥判定し、両者の判定結果か

ら、対象画素を欠陥画素であるか否かをさらに判断してもよい。欠陥判定レベルを可変に設定するこの閾値は、手動設定する場合のほか、たとえば、カメラ10にて画像データを圧縮符号化する際の圧縮モードや画像サイズに応じて変更可能としたり、欠陥画素であると判定された画素に被着されている色フィルタの種類に応じて閾値を変更してもよい。また、カメラ10における動画像撮像モード時と、静止画像をメモリカード16に記録する撮影記録モードとで閾値を異なるようにするとよい。

【0031】また、検出領域における周辺画素の画素値平均と対象画素とに基づいて、欠陥判定する際に、上記の演算処理部710および比較処理部712の構成に代えて、画素値平均に所定幅の上限値および下限値を設定し、対象画素の画素値が上限値を超えるか否かを比較判定し、さらに、下限値未満であるか否かを比較判定し、対象画素の画素値がこれら限界値の範囲内であるか否かを判定するようにしてもよい。この場合、設定処理部706は、これら上限値および下限値を設定する。

【0032】このように、欠陥画素検出部24は、YC変換後の画像データに基づいて、欠陥画素を検出するように構成されているが、これにかぎらず、たとえば欠陥画素の位置が予め判明している場合では、たとえば図12に示すデジタルカメラ800の構成例のように、その位置座標を欠陥補正部802,804にそれぞれ供給してよい。この例では、YC処理部18の出力を各ローパスフィルタ(LPF)806,808に入力し、LPF806,808の出力に対して、欠陥画素に対する画素値補正を各欠陥補正部802,804にて行うように構成されている。欠陥補正部802,804は、欠陥画素補正制御部810より供給される欠陥情報に従って、処理対象画素の画素値をその隣接画素の画素値で補間処理する。補正制御部810では、メモリ812に記憶されている位置情報に応じた欠陥情報を生成して各欠陥補正部802,804に出力する。

【0033】また、このような位置座標記憶による欠陥補正処理と、図1に示す実施例における欠陥画素検出処理とを組み合わせ、メモリ812に記憶された位置座標にはない画素位置の異常画素値を検出して補正するようにするとよい。また、欠陥画素検出部24は、フレームメモリなどにてYC画像データを記憶している場合には、その記憶領域における記憶アドレス等を出力するようにしてもよい。

【0034】図1に戻って、欠陥補正処理部26は、欠陥画素と判定された画素値をその隣接画素で補間処理する画素値補正処理部である。本実施例における欠陥補正処理部26は、欠陥画素検出部24より供給される欠陥情報に応動して輝度信号Yおよび色差信号Cに対して画素値を隣接画素で補間処理し、正常な画素をそのまま出力するとともに補間された画素値を出力する。

【0035】本実施例における欠陥補正処理部26は、現画素に対して、図10の画素1000で示すように、水平方向

に連続する1画素前および1画素後の2つの画素値を使用して、たとえばこれらの平均値を対象画素の画素値として置き換える補間処理を行う。この場合、いずれか1つの画素値で現画素の画素値を置き換える補間処理を行ってもよい。

【0036】また、欠陥補正処理部26は、現画素に対して、図10の画素1002で示すように、垂直方向に連続する前ライン画素および/または後ライン画素を使用して、現画素の画素値を補間するように構成されていてもよく、さらには、図10の画素1004で示すように、上下左右に隣接する4画素値を用いて現画素値を補正するようにしてもよい。また、図示はしていないが、現画素に対して斜め方向に隣接している画素値を使用して、現画素値を補正するようにしてもよい。これら補正処理に用いる画素については、カラーフィルタの配列にはよらずに、1画素分となりの隣接画素のYC画素を使用することができる。図10で示した例では、もともとはGフィルタが被着されていた画素に対する画素位置であったが、他のフィルタ色に対応する位置の画素についても、たとえば図11に示すように、対象画素に隣接する隣接画素のいずれか、もしくはいずれか複数、さらには隣接画素のすべてを使用して、欠陥情報に応じた画素の画素値を補正することができる。

【0037】これら補正のために使用される画素については、たとえば、各画素周辺の画素ごとに処理対象画素との相関度を別に求めて、相関度のより高い隣接画素を使用して欠陥情報に応じた対象画素を補正するとよい。また、元々の画素に使用されている色フィルタの種類に応じて、前述の閾値を異なるように設定するようにしてもよい。

【0038】欠陥画素補正処理部26の出力110,112は、ローパスフィルタ(LPF)28,30にそれぞれ接続され、LPF28,30は、画像データの高域成分を濾過してその中低域成分を通過させるディジタルフィルタである。LPF28,30の出力からは、正常に処理された輝度信号Yと、色差信号Cr,Cbとが出力される。LPF28,30の各出力114,116は、それぞれ圧縮処理部32に接続されており、圧縮処理部32は、たとえばレリーズ鉤の押下に応動して撮像されて、欠陥補正された画像データを圧縮符号化する。

【0039】本実施例における圧縮処理部32は、JPEG方式に準拠する静止画圧縮方式に準拠し、輝度信号Yおよび色差信号Cr,Cbそれぞれの各ブロックをそれぞれDCT変換し、量子化する。圧縮処理部32は、量子化したデータの係数を設定される圧縮率に応じて切り捨て、残る情報に対してハフマン符号化する。圧縮処理部32は、このようにして符号化した画像データを、カードインタフェース(I/F)回路34に出力し、インタフェース回路34は、着脱自在なメモリカード16に適合する記録形式にて、符号化した画像データと各種付属情報とを、その記

録領域に書き込む。本実施例におけるメモリカード16は、EEPROM、フラッシュメモリ等の半導体メモリを備え、回路34からのコマンドに応じて符号化データ等を所定の記憶領域に記憶し、また、記憶されたデータを読み出して回路34に出力する。また、メモリカード16に代えて、光および/または磁気にて情報を記録する情報記録媒体が使用されていてもよい。

【0040】システムコントローラ40は、カメラ10の各部を制御して、撮像および記録制御を行うマイクロコンピュータおよびその周辺回路による制御回路である。システムコントローラ40は、上述した欠陥補正処理部26における補間処理や、欠陥画素検出部24における検出処理にて行われる各種演算、比較処理をソフトウェアによる手順にて行ってもよく、その場合、たとえば欠陥を行う場合には図7に示した処理機能を実現するプログラムがコントローラ40にロードされる。

【0041】また、欠陥画素検出部24および欠陥補正処理部26は、上述のような情報記憶媒体に記録されたYC画像データに対し、その画像データの撮像時における欠陥画素を判定して、その画素値を補正することもできる。これは、たとえば、撮像信号を無圧縮にて情報記録媒体に記録し、その再生時に各種画像信号処理を行う場合などで有効である。この場合のカメラでは、欠陥画素補正処理を行わずに処理負荷が低減されるので、たとえば高画素密度にて撮像を行う場合に他の画像信号処理に要する時間を増やしたり、撮影間隔を短縮化することができる。

【0042】以上説明したように、欠陥補正処理部26では、YC処理部18にて処理されたYC画像信号が入力され、欠陥情報に応じた対象画素の画素値がその隣接画素で補間されるから、撮像素子14のフィルタ配列によらずに、欠陥画素を補正することができる。また、欠陥画素検出部24では、同様にYC画像信号が入力されて、YC画像信号に対する検出領域における各画素値に基づいて、処理対象画素の周辺画素に対する画素値の変化量が検出されて、撮像画像にてキズとして目立って現れる画素を検出することができる。

【0043】また、カラー撮像素子の出力をYC変換する際に、たとえば縦3画素の画素値を用いてYC画像信号が生成され、それをカバーする検出領域が設けられる場合には、YC変換の際に使用される画素にて派生する欠陥画素の影響を、欠陥補正の際に受けずに、良好な補正処理が行われる。

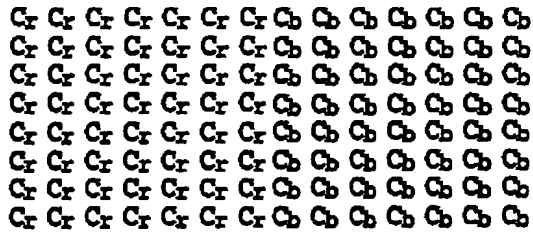
【0044】このように、上記実施例では、YC画像信号に対して欠陥画素の検出および補正処理を行っているため、フィルタ配列によらずに、また、画素間距離の大きな画素で補間処理を行うことなく、キズとして決定される画素を補正することができる。この場合、撮像素子における空隙画素、つまり、所定の画素位置における色成分フィルタ以外の成分がその画素位置にないために必

【図3】欠陥補正処理部および欠陥画素検出部に入力さ

712 比較処理部

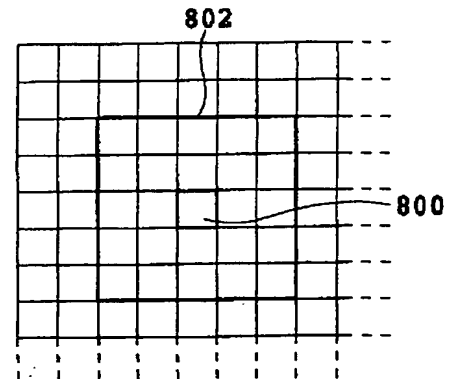
A 10x10 grid of 100 'Y' characters.

【図4】

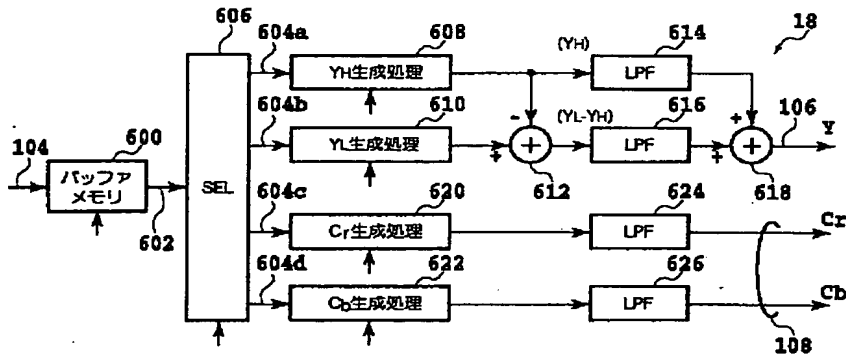


【図5】

【図8】

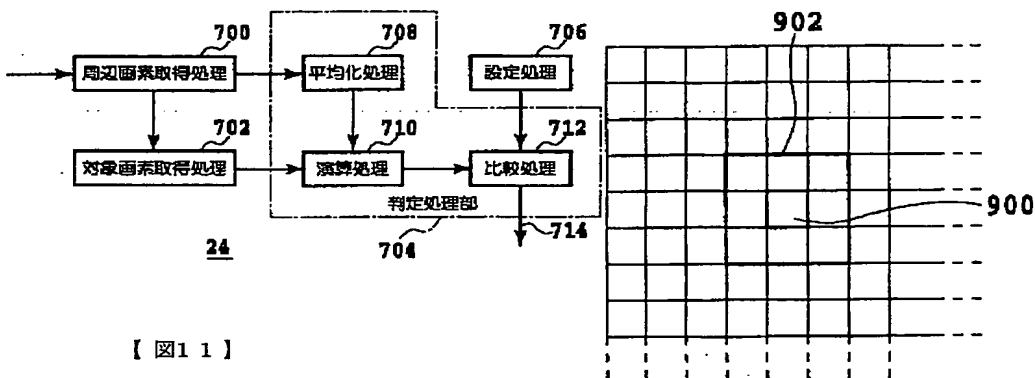


【図6】

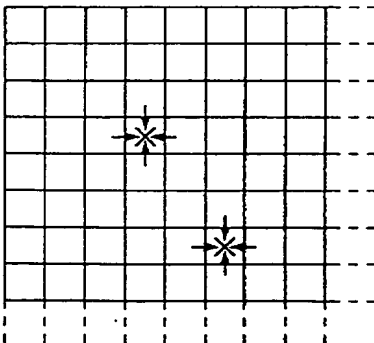


【図7】

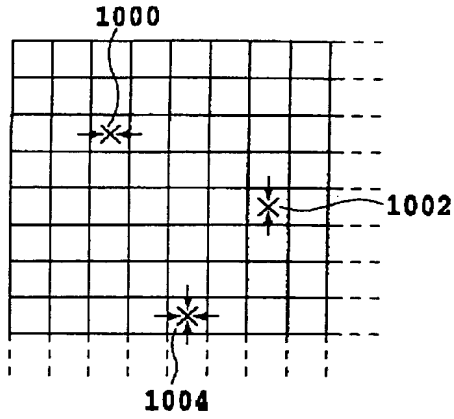
【図9】



【図11】



【図10】



【図12】

